



HEOMD Response to NAC HEO Committee Finding Regarding “Domestic Hydrocarbon Rocket Main Engine”

Bill Hill, Dep AA Exploration Systems Division
Jim Norman, Director Launch Services
27 July 2015

NAC HEO Committee Finding



NASA Advisory Council
National Aeronautics and Space Administration
Washington, DC

Dr. Steven W. Squyres

January 22, 2015

Mr. Charles F. Bolden, Jr.
Administrator
National Aeronautics and Space Administration
Washington, DC 20546

Dear Administrator Bolden:

The NASA Advisory Council held its first public meeting in Mississippi, January 14-15, 2015. This meeting had NASA Stennis Space Center on December 8-9, 2014, by schedule constraints related to the Orion Exploration F during that period.

We appreciated very much the considerable time you spent. As a result of our deliberations, and in accordance with recommendations and findings to the NASA leadership recommendations and one Council finding for your consideration approved three Committee findings for consideration by Administrators. Copies of the latter also are enclosed for

If you have any questions or wish to discuss further, please

Sincerely,

Steven W. Squyres
Chair

Enclosures

NASA Advisory Council Finding

Domestic Hydrocarbon Rocket Main Engine

Name of Committee: Technology, Innovation and Engineering Committee

Chair of Committee: Dr. William Balhaus

Date of Council Public Deliberation: January 15, 2015

Short Title of Finding: Domestic Hydrocarbon Rocket Main Engine

Finding: The Council believes that it is important for NASA and the nation to assess the need for a new domestic alternative to the currently available foreign hydrocarbon rocket main engines, and to invest accordingly. The Council also believes NASA can and should play a key role in this activity, especially in the development and understanding of advanced materials and metallurgy technologies for a future domestic hydrocarbon rocket main engine.

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The Council believes that it is important for NASA and the nation to assess the need for a new domestic alternative to the currently available foreign hydrocarbon rocket main engines, . . .

Answer: NASA did support and provide input to the Air Force's RD-180 study. In addition, NASA also participated in the review of the responses to the Air Force's RFI for engine and launch systems, and provided input.

. . . and to invest accordingly.

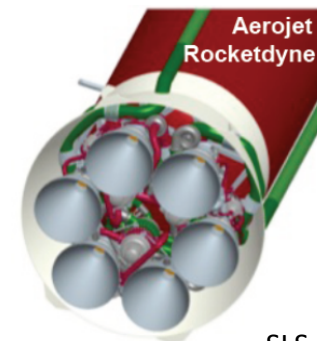
Answer: NASA is in the process of completing its lox/hydrocarbon studies. NASA has spent approximately ~\$47M FY13-FY15 on hydrocarbon engine and other related development work. Part of the FY15 funding will support a joint development test with the Air Force. Although the study activity may continue into FY16, NASA's funding for these activities ends with FY15.

Advanced Booster Risk Reduction

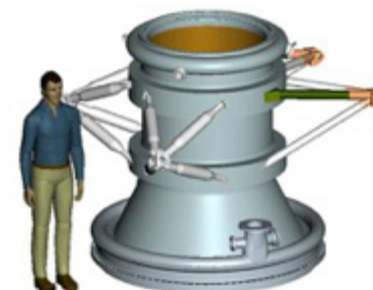
The Advanced Booster Engineering Demonstration and Risk Reduction (ABEDRR) awarded four contracts to **reduce risks** and **enhance affordability** for a wide range of **future booster concepts**.

Two efforts specifically focused on Risk Reduction for LOX/RP Propulsion

- ◆ Aerojet*: Risk Reduction for a LOX Rich Staged Combustion Booster Engine
- ◆ Dynetics/Rocketdyne*: Risk Reduction for Affordable Propellant Tanks and F-1 Derived Engines



AR-1 Concept on SLS Advanced Booster



Dynetics F-1B Main Combustion Chamber

ABEDRR LOX/RP Funding Summary

	GFY13	GFY14	GFY15	GFY16	GFY17	Total
NASA Funding						
Dynetics/AR	\$ 26.13	\$ 10.51	\$ 10.29	\$ -	\$ -	\$ 46.93
USAF Funding						
Dynetics/AR	\$ -	\$ -	\$ 4.48	\$ 9.66	\$ 2.54	\$ 16.68
SSC Test Facility	\$ -	\$ -	\$ 10.96	\$ 9.60	\$ 2.30	\$ 22.86
Total by FY	\$ 26.13	\$ 10.51	\$ 25.73	\$ 19.26	\$ 4.84	

* Contracts combined following Aerojet acquisition of Rocketdyne

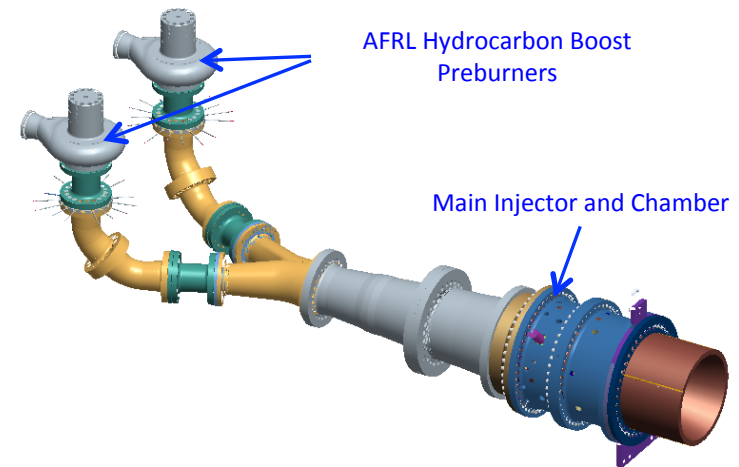
Advanced Booster Engineering Demonstration and Risk Reduction (ABEDRR)

LOX/RP Propulsion



- **Full Scale Ox Rich Staged Combustion Demonstration**

- Dynetics/Aerojet Rocketdyne task to demonstrate combustion stability of a full scale 500K thrust chamber
 - NASA funding covers hardware design/analysis of entire test rig and fab of primary components.
 - AF funding being applied to complete remaining hardware fab and test support.
- Testing at NASA SSC Test Stand E1
 - AF Funding NASA for test stand buildup and testing
 - AF providing two 250K USAF/AFRL Hydrocarbon Boost pre-burners for hot gas supply to Dynetics/AR test article
- Current Activity
 - On track to test integrated test article 1st-2nd quarter FY17.
 - Contract mod in work to add AF funding and scope
 - Critical Design Review planned for Sept 2015.



Advanced Booster Engineering Demonstration and Risk Reduction (ABEDRR)

LOX/RP Propulsion

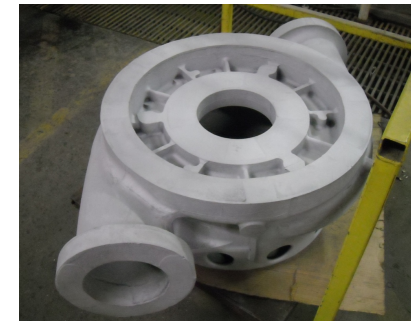


- **F-1B Engine Risk Reduction**

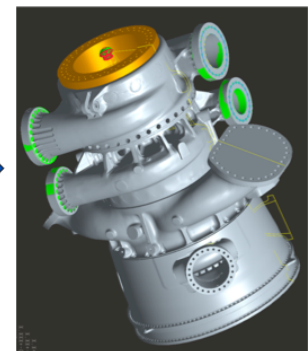
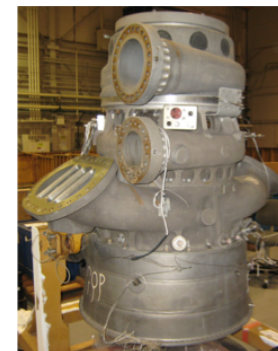
- Dynetics, along with their partner Aerojet Rocketdyne, are demonstrating the use of modern manufacturing techniques to produce primary components of a modified F-1 engine
- **Completed Activities:** Hot-fired heritage gas generator (GG); produced additively manufactured GG injector; developed high fidelity 3-D models of heritage turbomachinery from structured light scanning; produced new turbomachinery components using modern casting techniques
- **Current Activity –**
 - All tasks complete except Additively Manufactured Gas Gen test planned for Sept 2015 at MSFC



Gas Generator Testing at MSFC



Turbopump Volute Sand Casting



Three Dimensional Model developed from Structured Light Scanning



The Council also believes NASA can and should play a key role in this activity, especially in the development and understanding of advanced materials and metallurgy technologies for a future domestic hydrocarbon rocket main engine."

Answer: NASA has offered the use of its facilities and expertise to both the Air Force and to U.S. Industry.

-In addition to funded activity listed on the previous slide, a series of unfunded space act agreements exist between MSFC and U.S. industry

--The list of those companies is procurement sensitive information and cannot be provided in an open forum